

LINK BUBBLE SEXTANT

(OCTANT)

MODEL A-12

HANDBOOK

**DESCRIPTION - OPERATION
USE - ADJUSTMENT**

**LINK AVIATION DEVICES INC.
BINGHAMTON, N.Y.**

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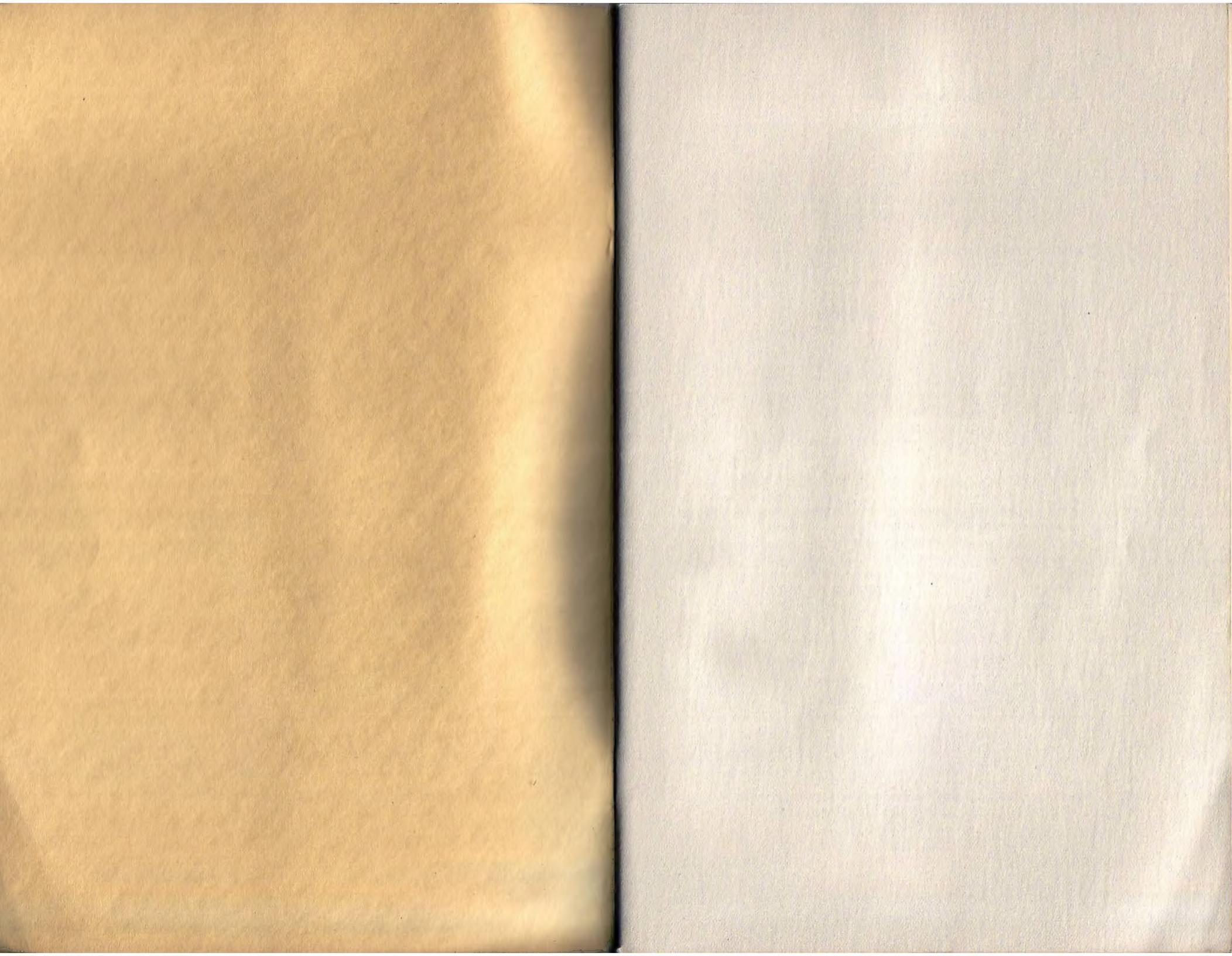


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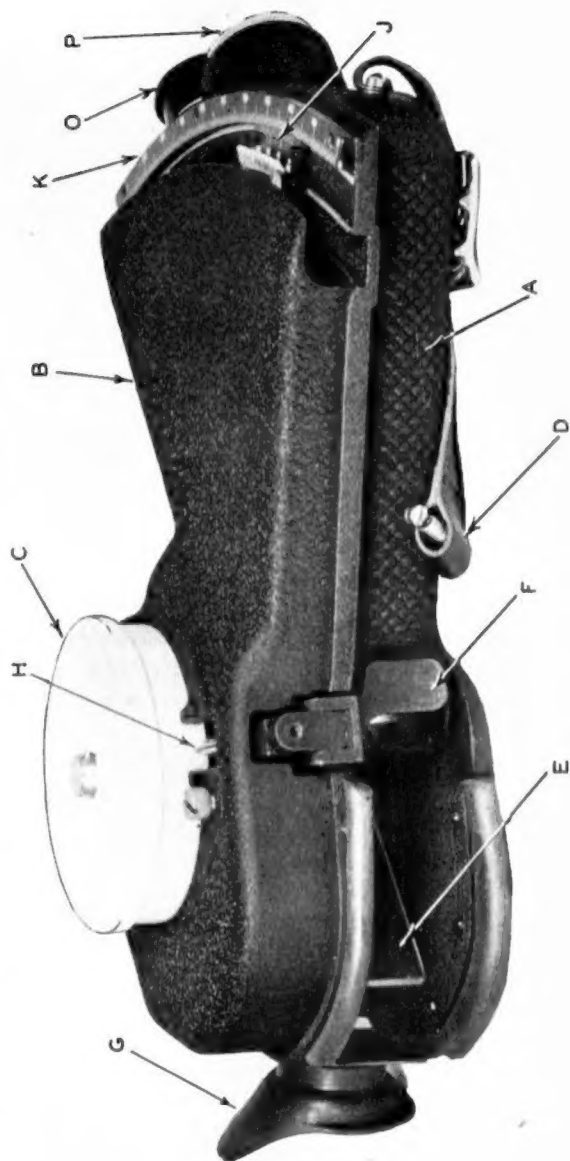
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A-HOUSING
B-COVER
C-DRUM
D-STRAP
E-INDEX MIRROR
F-TRIGGER MECHANISM

G-EYEPiece
H-PENCIL MARKER
J-VERNIER PLATE
K-SCALE
O-BUBBLE ILLUMINATION ASSEM.
P-DRUM-SCALE ILLUMINATION ASSEM.

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LINK SEXTANT, MODEL A-12

FIG. 1

SECTION I

INTRODUCTION

The Link Sextant, model A-12, is of the median type and uses a bubble as an artificial horizon. It is designed to fill the urgent need for a low priced Bubble Sextant which is both accurate and easy to use. This instrument is light in weight, mechanically simple, rugged, compact in size, and shaped to the hand. It has practically no protruding handles and parts to make it bulky and subject to easy damage. Particular attention has been paid to weight distribution, so that the instrument feels well balanced when held in the hand. This combination of light weight and correct balance eliminates muscular exertion and makes accurate observations easier to obtain. The Sextant is so engineered as to permit easy interchange of essential parts.

The use of spring loaded split gears eliminates backlash, and any possible wear as a result of long periods of service is also compensated for by these gears. Thus, at no time can backlash or lost motion develop between the revolving drum and the arm which carries the Vernier scale.

The A-12 Sextant employs only one index mirror of plane parallel glass which is actuated by the arm carrying the vernier scale. The use of the single index mirror simplifies the construction of the instrument as well as insuring accurate results with a minimum of maintenance and expense.

A series of sights on one or more bodies may be taken, and the approximate altitude (to the nearest degree or two) marked on the plastic drums (one drum for each body.) The navigator may then retire to his table where under better working conditions he can obtain the median (average) Sextant reading. This is done by setting the arm to the nearest whole degree altitude, as previously recorded on the drum, and then setting the pencil mark representing the median shot beneath the marker. Thus the same reading is obtained as when the sight was taken.

SECTION II

GENERAL DESCRIPTION

The model A-12 Sextant is a one piece frame of heat-treated aluminum, resulting in a rigid and durably constructed instrument unlikely to warp and strong enough to withstand shocks caused by rough handling. Naturally, however, an instrument of which accuracy is required should be handled with extreme care at all times. The Sextant itself is housed in a compact case providing space for extra batteries, bulbs, drums, and a spare bubble assembly.

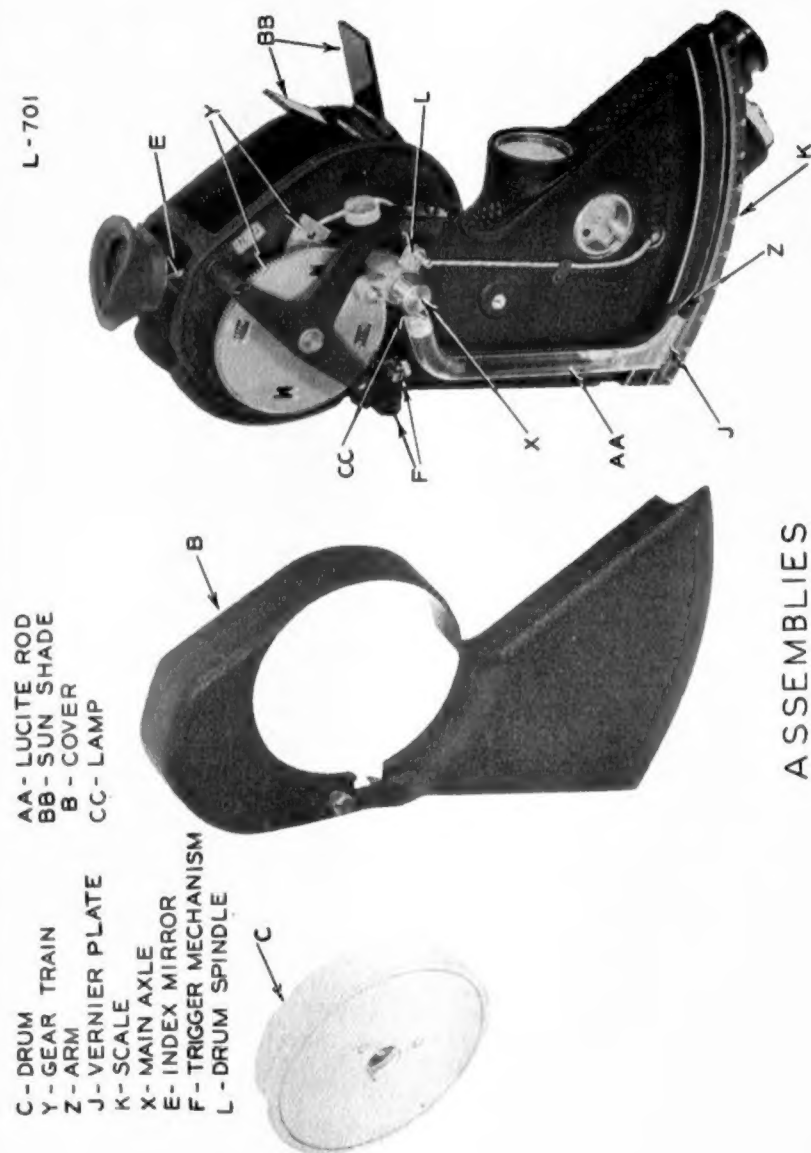
The design and construction is such that the revolving of the white plastic recording drum "C" (Figure 2) actuates a gear train "Y" which in turn gives motion to an arm "Z" upon which is fastened the vernier "J". The vernier scale "J" is read against a segment of a circle "K" which carries graduations indicating from 0 to 90 degrees. The arc scale is graduated in half degree divisions, and the vernier plate in two-minute divisions. These two-minute divisions are far enough apart so that interpolations to one minute or less may be read.

The shaft to which the arm is secured also carries the plane parallel glass index mirror "E"; consequently, there can be no lost motion between the index glass and the scale. Passing through the inside of the arm shaft is the main axle "X" to which is attached the spindle "L" which holds the drum. A pencil trigger mechanism "F" can be actuated so that by pressing the trigger a pencil mark will be recorded on the drum. Each time a sight is taken, the trigger is operated; therefore, it can be seen that a series of sights will result in a row of marks on the drum, the median or approximate average of which may then be determined by rotating the drum and aligning the middle mark beneath the pencil point. The reading thus obtained is the median or approximate average reading. The procedure is described more fully in the section dealing with "Operating Instructions".

The bubble assembly unit (figure 2A) is carefully adjusted at the factory and locked in position. With reasonable care of this unit it is unlikely that further adjustment should be necessary. Provision for such adjustment is made, however, and can be utilized whenever it becomes necessary. See Section VII - Adjustments.

The bubble assembly which is easily removed comprises a bubble housing, two lenses with seals and locking rings, a filler hole, and the bubble fluid.

Illumination of the bubble for night observations is obtained by use of a self-contained readily removable lamp assembly "O"



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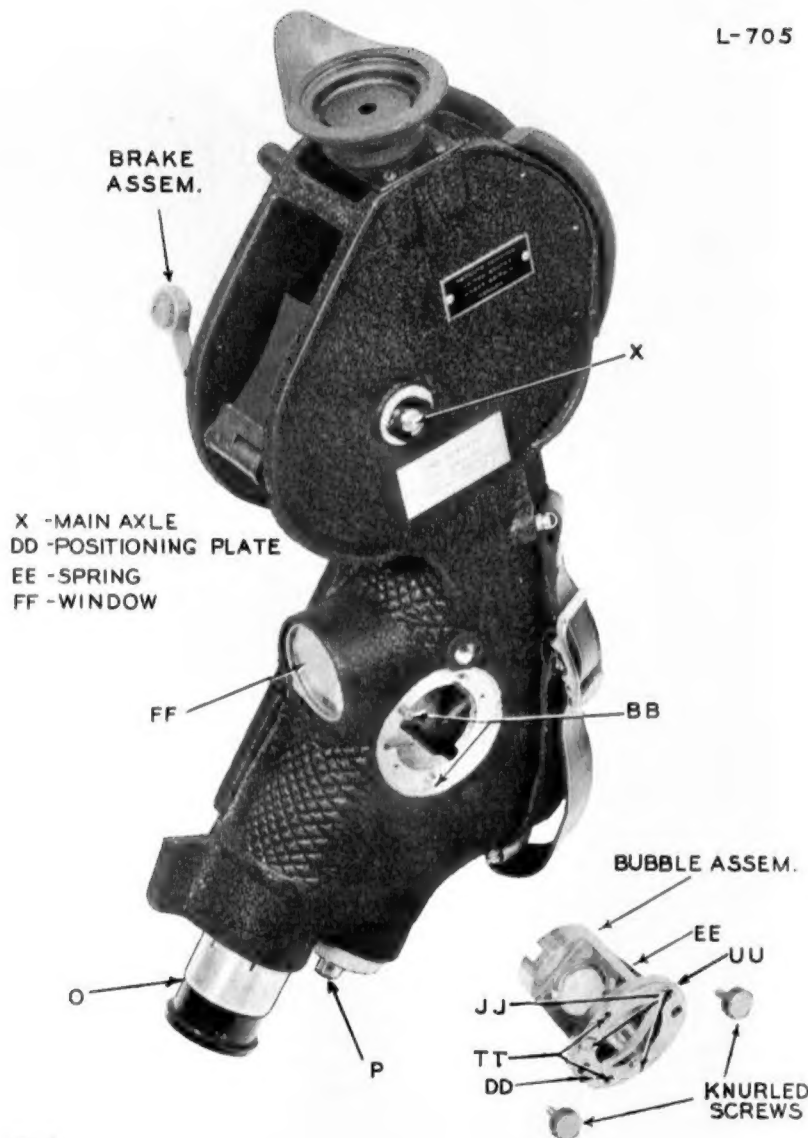


FIG. 2 A

(Figure 2A) which includes a lamp, battery, battery case, switch, and rheostat. Daylight illumination of the bubble is obtained through a circular glass window "FF" (Figure 2A) located in the top of the Sextant.

Illumination of the scale and vernier is accomplished by means of a separate lighting system. A lamp "CC" (Figure 2) is located under the semi-transparent drum to illuminate the sight marks made on the drum. A lucite rod "AA" (Figure 2) also uses light from this bulb and transmits it to a point where the vernier plate and the adjacent section of the scale are illuminated. The bulb is turned off or on by a push button located below the bubble housing lighting assembly. This push button housing "P" (Figure 2A) is also a readily removable unit and contains space for a battery.

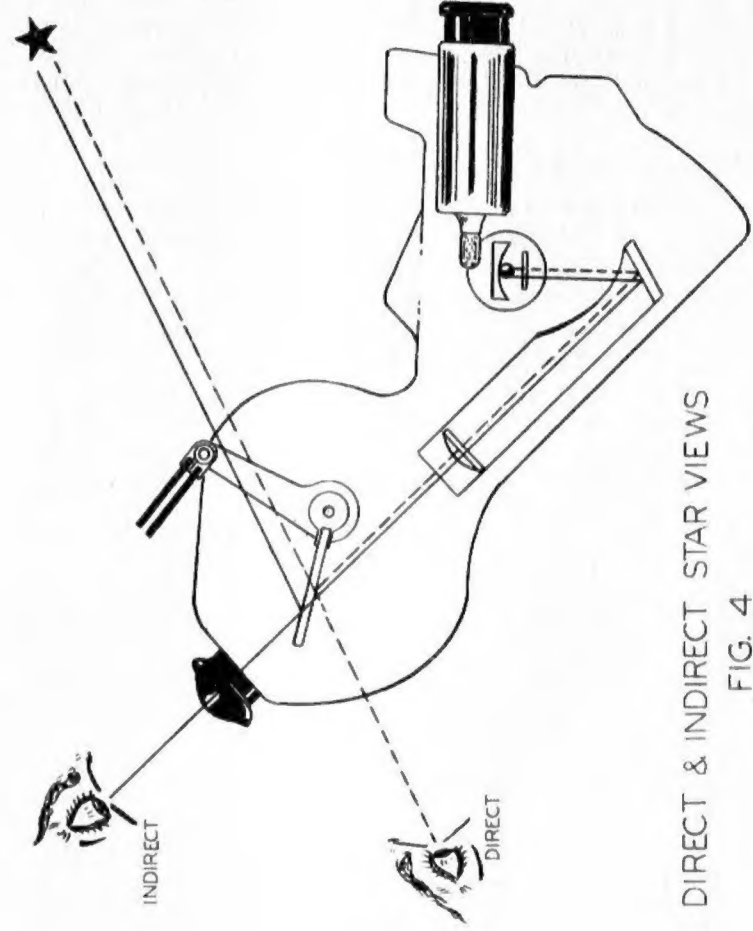
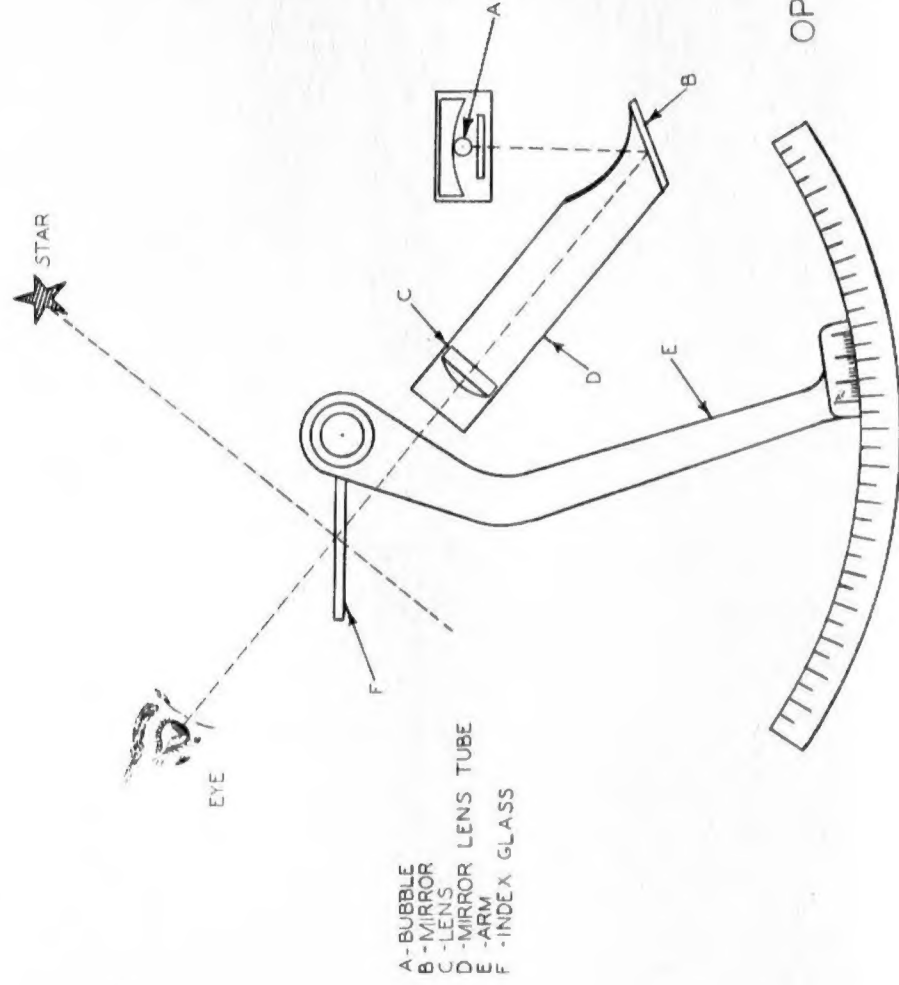
Two sun shades "BB" (Figure 2) are provided for reducing glare, one of which passes 10 percent of the light, and the other 1 percent of the light. These shades are mounted in a swinging bracket which enables them to be placed in the desired position where they are then held by friction.

A tubular lens-mirror assembly (Figure 3 and 5) is contained within the Sextant, the purpose of which enables proper focusing of the bubble and its reflection to the eye as shown in Figure 3. It can here be seen that a movement of the Sextant arm and consequently the index glass also, enables the star to be brought into a position so that the two objects (bubble and star) appear as one.

Figure 4 shows two positions of the eye in viewing celestial bodies. One is a direct view of the star and the other is an indirect view of the star. For sighting stars, the direct view facilitates finding the desired body, while on the other hand the eye piece and sun shades adapt themselves comfortably in sighting the sun.

The function of the split type-spring loaded gear is shown in Figure 2. It can be seen that if the two halves of the gear are offset in opposite directions, a definite tension will be imposed upon the springs. If a pinion is meshed with the gear while the tension is maintained, it is quite evident that when the tension is released the pinion will be under constant pressure, and any lost motion between the two is absolutely eliminated. Also, any wear that occurs from long period of service is immediately taken up by this spring loading. The tension is regulated so that no binding exists between the pinion and gear.

It will be noted that both the large gear and the sector gear on the arm are of the split type.



SECTION III

DETAILED DESCRIPTION

- | | |
|---------------|-----------------------------|
| 1. Housing | 7. Marking Pencil & Trigger |
| 2. Scale | 8. Index Mirror |
| 3. Vernier | 9. Sun Shades |
| 4. Arm | 10. Bubble Assembly |
| 5. Gear Train | 11. Lens Tube Assembly |
| 6. Drum | 12. Bubble Illumination |
| | 13. Scale Illumination |

1. HOUSING (Figure 1).

The housing or frame of the entire Sextant is cast in one piece. Openings and recesses for the various sub-assemblies and accessories are then machined, and lastly, after suitable masking, the finish is baked on.

2. SCALE (Figure 2).

The scale is of duralumin, carefully shaped and ground to size. It is then engraved, polished, anodized, and the engraving filled with white. Its position on the housing is determined and fixed by the mounting screw holes in the housing which are drilled in a jig.

3. VERNIER (Figure 2).

The vernier plate is manufactured similarly to the scale and is held in place on the Sextant arm by two screws. The screw holes in the vernier are elongated to facilitate final adjustments.

4. ARM (Figure 2).

The Sextant arm which carries the vernier plate in its movement along the scale is secured to a solid shaft, which fits holes..machined for the purpose..in the Sextant housing. This shaft to which the arm is secured also carries the index mirror, thus obviating any possibility of lost motion between the two parts.

5. GEAR TRAIN (Figure 2).

Travel of the arm along the scale is accomplished by means of a train of reduction gears actuated by a recording drum. The gears are the split type with sufficient spring tension between the two halves of each gear to prevent any backlash developing, either as a result of irregularities in the gears themselves or as a result of wear during service.

6. DRUM (Figure 1).

The drum by means of which the arm is set during use of the Sextant also serves as a recording drum. As each observation is made, a penciled line is recorded on the edge of this drum. Several sights thus may be made in a short time and recorded on the drum to be read later. The drum is removable and so arranged that additional drums may readily be used for obtaining several sights on each of additional stars. Each drum may later be replaced on the Sextant to obtain its reading as outlined in "Operating Instructions".

7. MARKING PENCIL AND TRIGGER (Figure 1).

A trigger is conveniently located to the left thumb. This trigger actuates a slide which carries a short pencil lead. When the trigger is depressed, a pencil line is left on the rim of the drum.

8. INDEX MIRROR (Figure 5).

The index mirror is clear glass optically flat and parallel. By means of a die cast clamp, it is solidly secured to the same shaft that carries the Sextant arm. Once adjusted properly, as described later, there can be no lost motion between the arm and this mirror.

9. SUN SHADES (Figure 5).

The sun shade assembly comprises two adjustable optically flat glass screens. One allows one percent and the other allows ten percent of the light to be transmitted. Both shades are mounted on a bracket in such a manner that either or both may be used. This bracket swings on the index mirror shaft with sufficient friction to hold it in whatever position it is placed.

10. BUBBLE ASSEMBLY (Figure 2A and 12)

The bubble assembly, which is readily removable from the Sextant housing, consists of a main brass housing which is machined to take the component parts of the bubble assembly and the positioning plate. The bottom of the bubble chamber is a clear lens, ground and polished optically flat and parallel. This lens is held in place by a lead seal and screw type lock ring. The top lens of the bubble chamber is ground and polished to the proper curvature on its inner surface, and is also held in place by a screw type lock ring and lead seal. The chamber is filled to the correct point with Xylene. A filler hole, plugged by a small Bristo type screw, is located in the end of the bubble assembly housing opposite the positioning plate.

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F-INDEX GLASS
RB-SUN DIMMER GLASSES
P-BATTERY & LIGHT ASSEM. TO
ILLUMINATE LUCITE ROD
HH-LENS
FF-ILLUMINATION WINDOW
O-NIGHT ILLUMINATION ASSEM

CROSS SECTION VIEW
& BUBBLE ASSEMBLY

FIG. 5

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13. SCALE ILLUMINATION

Both the scale and the semi-transparent recording drum are illuminated by one lamp, (Figure 2). This lamp is located under the recording drum and illuminates it directly. A portion of the light is carried along a lucite rod to the vernier plate and the adjacent area of the scale. A separate battery is provided for this lamp so that the illumination of the recording drum and the scale is entirely independent of the bubble illumination system.

SECTION IV

OPERATING INSTRUCTIONS

- | | |
|-----------------------------|-------------------------|
| 1. General Operation | 4. Illumination, Bubble |
| 2. Median (average) sight | 5. Illumination, Scale |
| 3. To change Drums | 6. Batteries |
| 7. Altitude Scale & Vernier | |

1. GENERAL OPERATION

To operate the Sextant, slip the left hand through the strap with the heel of the hand firmly against the housing. The fingers should extend well over the top, with the middle finger over the window which illuminates the bubble by daylight. The amount of daylight permitted to go through is controlled by raising or lowering this finger.

The thumb of the left hand should rest lightly but comfortably on the marking trigger. The top part of the case on which the fingers of the left hand rest should be horizontal when the Sextant is being used. The thumb and fingers of the right hand lightly grasp the operating drum which is then rotated as necessary to bring the celestial body and the bubble into coincidence. The correct position as seen in the Sextant should be such that the bubble and the body appear as one object in the center of the circular chamber. In learning to use the Sextant, it is excellent practice to merely attempt the centering of the bubble without sighting a body. Such practice promotes skill in controlling the bubble and positioning it wherever desired.

The Sextant can be used in either of two ways in sighting celestial bodies. (Refer to Figure 4). For observation of the sun, the eyepiece and sun shades should be used. This is referred to as observing the body indirectly because the body is reflected to the eye from the index glass. For observation of the stars, the direct method of sighting is preferred. This simplifies star finding and eliminates the possibility of observing the wrong star.

In both methods it is only necessary to have the body in the center of the bubble (bubble not touching the sides of the bubble housing) to obtain a correct altitude shot.

To use the Sextant for sighting the sun, hold the instrument in the normal manner and face in the direction of the sun. Position the sun shades so that no glare will be reflected to the eye when the body is in the field of vision. Place the right eye against the rubber eye piece and look through the small round

opening in it. With the right hand, revolve the drum until the sun is seen in the field of vision. It may be necessary to move the Sextant around somewhat to facilitate finding the objective, but this offers no difficulty if it is held in a position which is in line with the sun.

Movement of the scale end of the Sextant in the vertical plane, using the eye as the pivot point, causes the bubble to travel toward the 90 degree end of the altitude scale with upward motion. Downward motion of the scale end causes the bubble to fall to the zero end of the altitude scale. Rocking the Sextant from side to side causes the bubble to rise to the high side of the bubble chamber.

The indirect view, as described above, offers difficulty if used to sight the stars, this being due to the fact that there are countless stars in the sky, and indirect sighting through the Sextant gives no accurate indication as to which star is being observed. Also, the sizes of the nightly bodies are relatively small and difficult to see unless viewed directly through the index glass. To sight through the Sextant directly, again hold the instrument in the normal position and with the head turned up toward the star to be observed, place the Sextant against the front of the face in such a way that the right eye lies between the rubber strips on the Sextant housing. The eye thus looks directly through the index glass at the star. It will now be seen that a complete vision of the stars is possible, and the selection of a particular one for observation is relatively easy. To bring the star into the field of vision, turn on the bubble chamber illumination to a point where the star and bubble are both visible and revolve the drum until the correct bubble-star position is obtained.

The bubble travels opposite to Sextant movement in this case as upward movement of the scale and produces bubble movement toward the zero end of the scale. Downward movement of the scale end causes the bubble to travel toward the 90 degree end of this scale.

2. MEDIAN (AVERAGE) SIGHTS

To obtain the median reading the procedure is as follows: A series of sights should be taken, pressing the marking lever each time the celestial body appears to be in the proper position relative to the bubble. These sights should be only a few seconds apart, and an odd number such as 11, 15, or 21 observations made. If eleven sights are to be taken, the time should be recorded at the instant of marking the sixth shot or, if preferred, the time can be marked at the first sight then again at the last, in this case using the mid-time. Upon completion of the series of shots, the median reading is obtained as follows: Note that if eleven shots were made, eleven pencil marks will be found around the rim of the

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DRUM & SIGHT MARKS

FIG. 6

operating drum (Figure 6). Count along these marks to the sixth one, (the middle one on the drum), rotate the operating drum so that this mark is under the marking pencil, then read the scale. This reading will be the median (approximate average) of the eleven shots.

3. TO CHANGE DRUMS

Lift the drum straight off the Sextant. It will be noted that the drum is fitted to a flange (Figure 11) which has three studs. Two of these studs are small and long enough to extend through the operating drum. The remaining stud is shorter and larger so that it is impossible to put the drum on in the wrong position.

Observations may be taken on two or more celestial bodies using one drum for each body, after which the drums can be pocketed for later reference. Before removing the drum, the name of the celestial body, the time of observation, and the approximate scale reading should be written on the drum in pencil.

CAUTION: One complete revolution of the operating drum covers approximately 5 degrees on the scale. Therefore, if the approximate scale reading is not noted, it would be possible to return the drum to the original markings, but with an error of multiples of 5 degrees.

After observations have been taken on two or more stars, using a separate drum for each star, the navigator may return to his work table, and under conditions of comparative comfort, replace the drums one by one, return the drum to the median mark, and then read the median altitudes from the scale. (Be sure to return the vernier to the approximate reading marked on the drum before turning to the middle mark.)

4. ILLUMINATION, BUBBLE

The black bakelite knob (Figure 8) on the end of the Sextant away from the observer is a rheostat which controls the intensity of bubble lighting for night observations. With this rheostat fully rotated to the left (counterclockwise), the switch is off. Rotation in the other direction closes the switch and regulates the intensity. The lower the light can be turned, (and still see the bubble) the more visible the star will be. The entire illuminating housing assembly may be removed from the Sextant by pulling straight out on the rheostat. With the unit withdrawn, the bulb or battery may be replaced, or the assembly can be used as an emergency flashlight. To replace a battery, merely pull the bulb end of the case off the cylindrical part. When placing a battery in the case DO NOT drop the battery in the rheostat end. Push the

battery into the bulb end FIRST and then push the rheostat end over the battery and bulb end case. Excess pressure or movement of the copper contact results in an open circuit in this unit. The bulb is a screw-in type which is changed in a normal manner.

5. ILLUMINATION, SCALE

Illumination of the operating drum and vernier scale is obtained by a separate battery and switch (Figure 8). A push button switch is located directly below the rheostat for the bubble illuminating system. This push button switch will stay in the "on" position when depressed and moved slightly sideways. To release the switch, merely press the button and move it to the center position and release. To obtain access to the battery, grasp the switch housing with the thumb and finger and draw it straight out of the Sextant. The operating drum is illuminated by a bulb located under it, and light from the same bulb is transmitted through the lucite rod to the vernier plate and adjacent scale.

6. BATTERIES

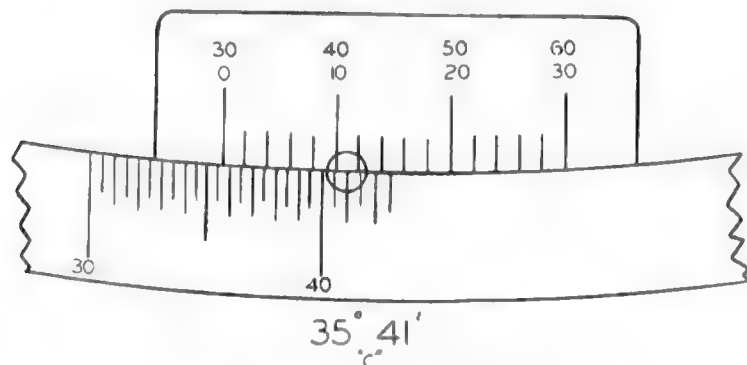
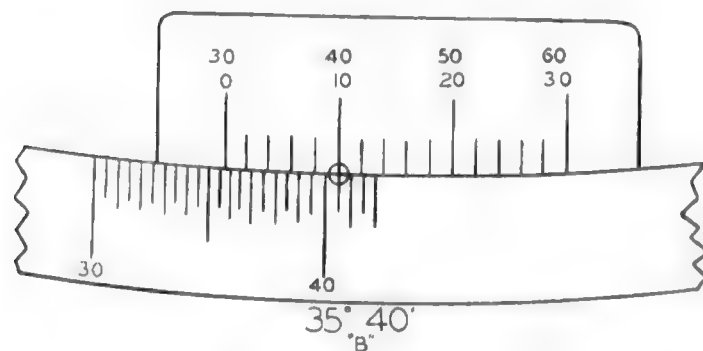
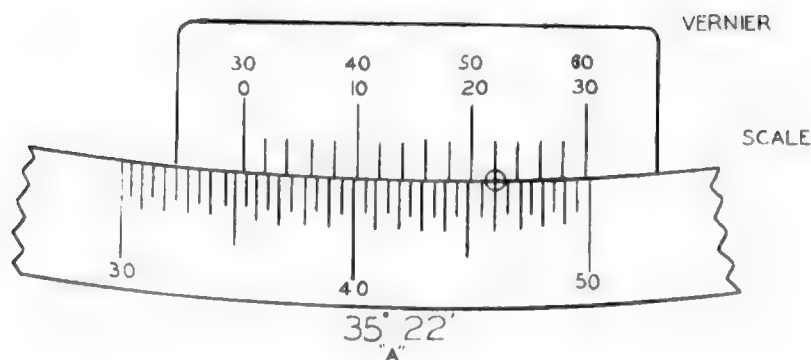
As all navigators know, batteries do not last long in a Sextant that is being used. Therefore, although the A-12 Sextant has two batteries, spare batteries should always be available. CAUTION: Never put the Sextant away after use without first removing the batteries. Even if the Sextant is to be used the following night, remove the batteries before putting it away.

7. ALTITUDE SCALE AND VERNIER

On the lower scale the degree numeral appears each ten degrees; these are the longest lines on the scale. Between these long lines are medium length lines each of which represents five degrees, and the next to the shortest lines are the one degree marking lines. The shortest lines represent half degrees or 30 minutes, and these appear midway between each whole degree. To read the scales, first note the degree reading which appears to the left of the long 0-30 vernier line, this represents the number of whole degrees. Next, to obtain the number of minutes, note whether the 0-30 vernier line is to the left or to the right of the half degree mark. This will determine whether the minute reading is less or more than 30 minutes.

In order to spread out the markings and facilitate reading, two rows of figures are used on the vernier scale. The lower row of figures (0, 10, 20, 30, Figure 7) covers the conditions where the altitude reading ends in 30 minutes or less.

Find the line on the vernier scale which most nearly agrees



VERNIER SCALE READING
FIG. 7

with a line on the large scale. As an example, let it be assumed that the 0-30 vernier line is to the left of the half degree (30 minute) mark. Immediately it is known that the minute reading is less than 30 and, therefore, by reading the lower row of figures on the vernier scale, the minute reading is obtained "A" (Figure 7).

Example: "A" (Figure 7) reads 35 degrees 22 minutes. It will be noted that each division on the vernier represents 2 minutes.

The upper row of figures (30, 40, 50, 60) covers the remaining condition where altitudes have endings between 30 minutes and 60 minutes.

Taking this condition where the 0-30 vernier line is to the right of the half degree mark (or more than 30 minutes) the procedure is exactly the same with the exception that the upper row of figures on the vernier scale is used. See "B" (Figure 7), reading 35 degrees 40 minutes.

Example: "B" (Figure 7) reads 35 degrees 40 minutes. Here again each division represents 2 minutes. As an example, the third short division from the long 0-30 line would read either 6 minutes or 36 minutes, depending upon where the 0-30 line was located with respect to the lower scale as described previously.

If no two lines coincide, but two lines on the vernier scale appear to be the same distance from two lines on the large scale, the reading on the vernier scale is interpolated between those two lines.

Example: "C" (Figure 7) shows that the reading is more than 35 degrees 40 minutes but less than 35 degrees 42 minutes, in this instance the interpolation being 35 degrees 41 minutes.

SECTION V

DIS-ASSEMBLY

1. Bubble Assembly
2. Marker
3. Index Mirror Assembly and Gears
4. Lens Tube Assembly

1. BUBBLE ASSEMBLY

To dismantle the Sextant for repair or overhaul, proceed as follows:

(a) Remove the rubber eye-piece.

(b) Remove the drum, making sure that the pin "V" (Figure 11) is over the notch on the drum. If pin "V" is not in this position, rotate the drum until the vernier is at either extreme end of the scale. Continue rotating the drum by adding slightly more pressure and thereby causing a clicking sound. The drum rotates while the center pin remains stationary under these conditions. When the pin is over the notch remove the drum.

(c) Loosen the knurled screw adjacent to the drum and remove the cover.

(d) Remove the bubble lamp assembly by pulling straight out on the rheostat knob.

(e) To remove the bubble chamber when, as, and if necessary, merely remove the large knurled screws and pull on the side that has the small handle. **CAUTION:** Do not try to remove bubble assembly without first removing the bubble lamp assembly. Failure to do this will result in a broken bulb in the lamp unit. Under no circumstances must the three small screws be disturbed. These screws are used to adjust the bubble to the Sextant, and if they are disturbed, the adjustment will be ruined.

The bubble positioning dowel pin and positioning plate holes are fitted individually. The hole in the plate which is to be precisely fitted to the pin is drilled under size and then carefully reamed to the pin size so that there is no lost motion.

2. MARKER

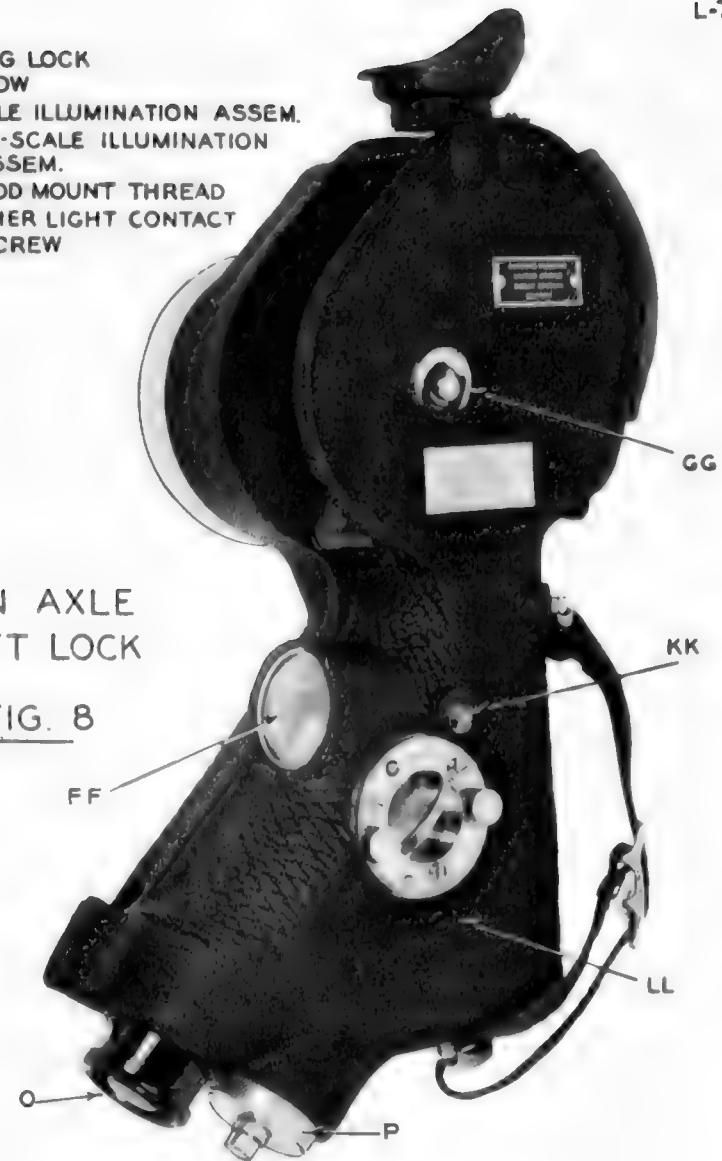
Remove the marking pencil holder by pressing outward with the left index finger (Figure 9) to release it from the trigger "A", and push the holder upward and then merely pull the holder out the rest of the way.

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GG-SPRING LOCK
FF-WINDOW
O-BUBBLE ILLUMINATION ASSEM.
P-DRUM-SCALE ILLUMINATION
ASSEM.
KK-TRIPOD MOUNT THREAD
LL-VERNIER LIGHT CONTACT
SCREW

MAIN AXLE
SHAFT LOCK

FIG. 8



3. INDEX MIRROR ASSEMBLY AND GEARS

(a) Remove the three screws from the countershaft and trigger bracket assembly "N" (Figure 11). Lift bracket from assembly.

(b) Remove the spring lock "GG" from the left hand end of index mirror shaft (Figure 8).

(c) Lift both the assembly which carries the drum and the large split gear to a point where the split gear will clear its shaft and permit removal. The assembly which holds the drum may now be pulled out the rest of the way.

(d) Next, loosen the clamp screw which secures the index mirror assembly to its shaft. The arm, sector, and mirror shaft assembly may now be withdrawn. **CAUTION:** This will free the index mirror and sun shade assembly. Care should be taken that they are not dropped.

(e) The arm and socket assembly may now be turned over sufficiently to permit access to the socket mounting screw on the under side of the arm. Remove this screw and socket, leaving the socket attached to the wire leading to the battery.

(f) Remove the lucite rod by removing the screw at the lower end of the rod.

(g) Remove the wire by removing the screw "IL" (Figure 8) and turn aside the spring clips covering the wire.

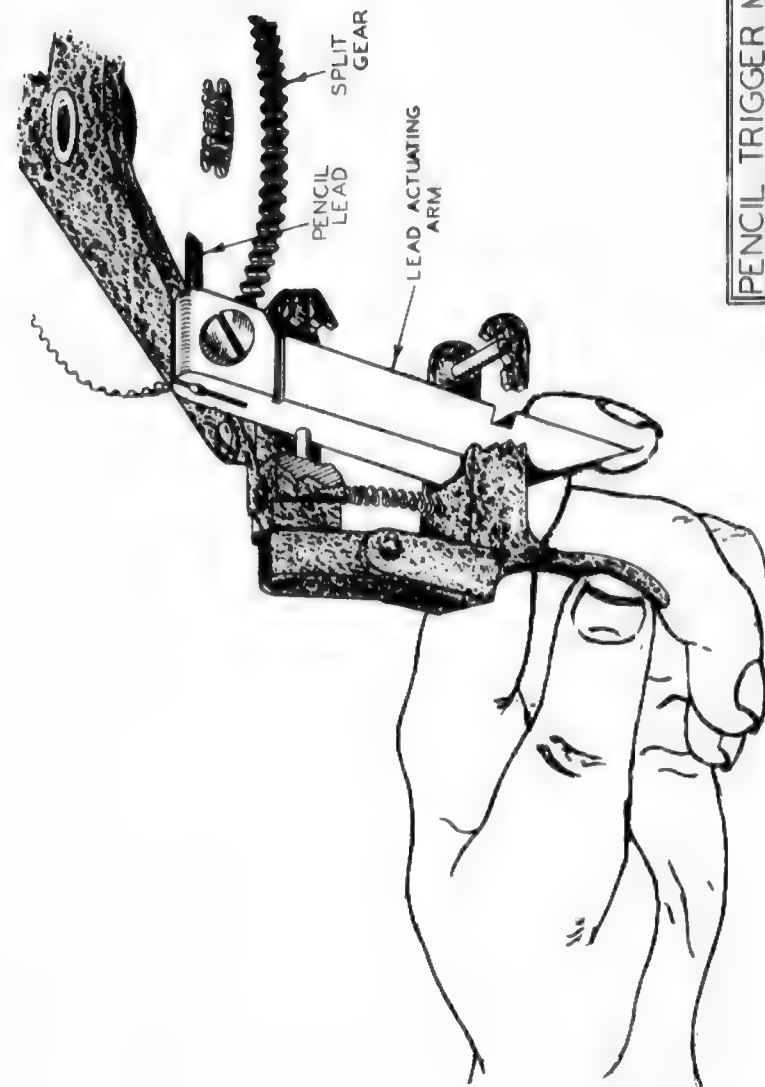
4. LENS TUBE ASSEMBLY

The lens tube assembly is held in place by a set screw "Q" (Figure 11). Remove this screw, and the assembly may be pulled straight out of the case.

CAUTION: Care should be taken to avoid getting finger prints on the lens tube mirror. This is a first surface mirror and very easily scratched. If there is necessity to clean it, dust particles should be removed with a camel's hair brush, and if further cleaning is necessary, a good quality of lens cleaning fluid should be used. Use only a good quality of lens tissue and be careful to avoid undue pressure. If the objective lens requires cleaning, the same precaution should be taken.

Method of removal of the forehead bead and eye piece is obvious. The circular glass in the top of the Sextant window is held in place merely by a snap ring. Remove battery case "D" (Figure 8) by pulling straight out.

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PENCIL TRIGGER MECHANISM

FIG-9

SECTION VI

ASSEMBLY

- | | |
|-------------------------|----------------------------|
| 1. General | 6. Vernier Plate and Light |
| 2. Lens Tube | 7. Marking Pencil |
| 3. Bubble Assembly | 8. Brake (Marking Drum) |
| 4. Arm and Index Mirror | 9. Filling Bubble Cell |
| 5. Split Gears | 10. Caution |

1. GENERAL

After any necessary replacement parts or assemblies have been obtained, reassembly of the Sextant should be done as follows:

2. LENS TUBE ASSEMBLY

(a) Assemble the objective lens "HH" (Figure 5) into the adjustable sleeve of the lens tube and lock the lens in place with the snap ring. Then screw the sleeve into the lens tube assembly.

(b) A hole will be noted in the side of the lens tube, and a set screw on the arm side of the Sextant, approximately opposite the tripod mounting socket. The tube assembly should be slid into the Sextant in such a way that the hole will line up with the locking screw hole. The screw should be removed from the hole while the tube is inserted, and when it can be seen that the hole is properly lined up, insert the locking screw and tighten securely.

3. BUBBLE ASSEMBLY

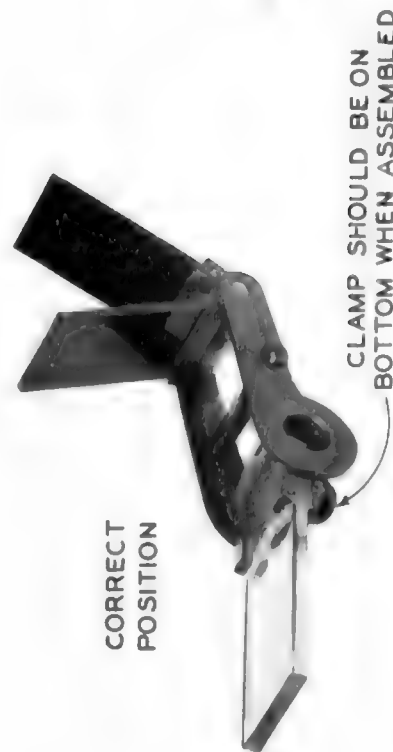
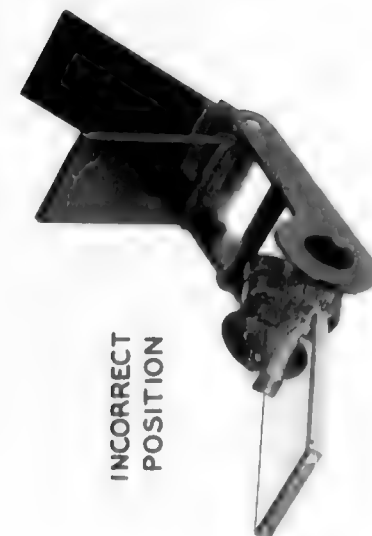
To replace the assembly, simply slide the unit straight into the Sextant housing with the dowel holes aligned with their respective pins. With the assembly thus correctly positioned, the spring will immediately rotate it to its proper place as indicated by the arrow. Insert the two knurled screws and tighten them finger tight. (It is not necessary to use a wrench.)

4. ARM AND INDEX MIRROR

(a) Attach the light socket, with its wire securely soldered to the Sextant arm.

(b) Before installing the index mirror into the Sextant, the assembly must be turned so that the clamping screw is underneath instead of above (Figure 10).

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INDEX MIRROR & SUN SHADE ASSEMBLY

FIG. 10

(c) Hold the sun shade and mirror assembly in the Sextant with the thumb and fingers of the left hand and insert the Sextant arm shaft through the side of the Sextant. Extend this shaft through the sun shade and mirror assembly to the other side of the Sextant.

This shaft must fit freely, (have no bind) but no slack or lost motion should be evident.

(d) Fasten illuminating wire along frame with clips and also replace socket and screw "LL".

5. SPLIT GEARS

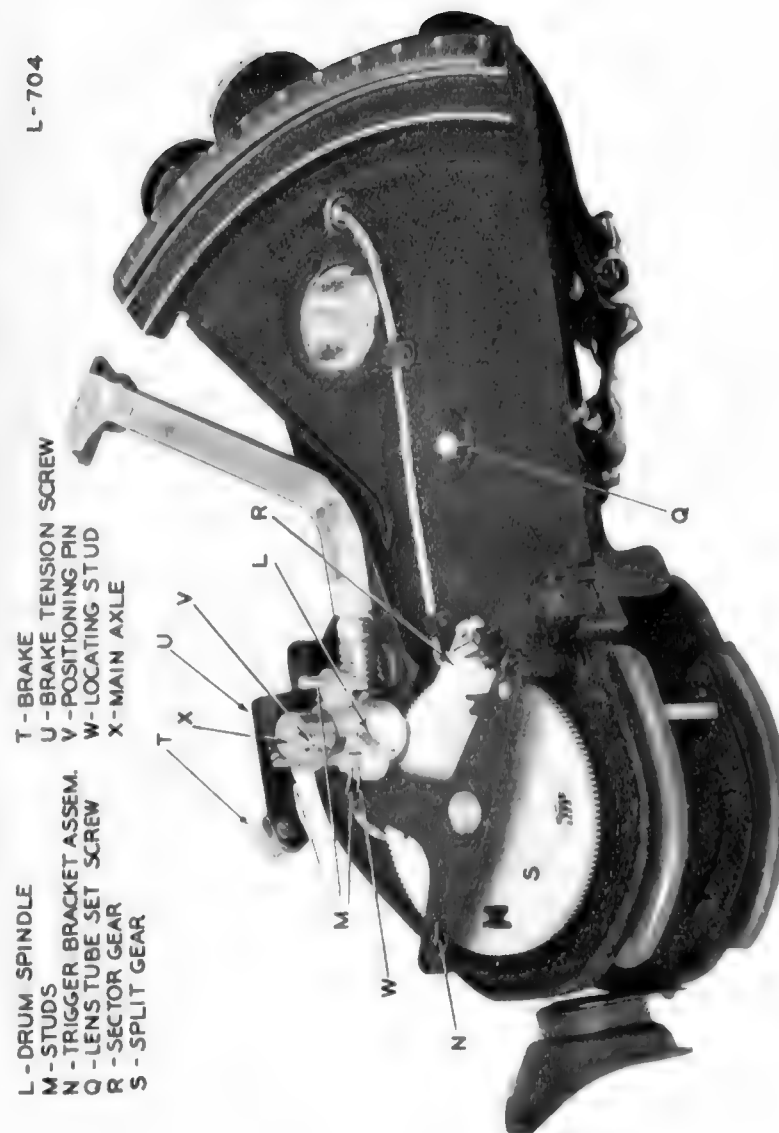
Installation of the split gear and the split gear sector (Figure 11) and proper tension on each is obtained as follows:

(a) Swing the Sextant arm to the right to a position well off scale (see Figure 11). This will leave the left hand portion of the sector gear exposed during ensuing assembly. With both halves of the gear opposite each other, the movable part of the gear sector should be rotated two teeth on the fixed portion, and then clamped in this position with a small C clamp. Before putting the large split gear in place, one half should be rotated against the other half one tooth, then the two halves held in this position by a small C clamp located near the edge of the gears. Do not tighten these clamps too tightly.

(b) Insert the drum shaft assembly mechanism in the hollow index mirror shaft and lower it part way into place. Holding this shaft with one hand, place the large split gear over its bearing with the other hand. Both the large gear and the drum shaft assembly may now be lowered into place while oscillating the large gear slightly so that its pinion will mesh properly with the sector gear. Replace locking spring "GG" (Figure 8). With these two assemblies in place, replace the spider bracket and secure it with its three screws. The two small clamps may now be removed and the spring lock replaced on left hand end of index mirror shaft.

6. VERNIER PLATE AND LIGHT

(a) If the vernier plate has been removed, it should now be replaced. The plate holes are drilled over size to allow for adjustment, and when replaced, the position of the plate should be about midway of its available adjustment. It should be shimmed as necessary to bring its surface flush with the surface of the altitude scale. There should be approximately .002" clearance between the vernier and the altitude scale throughout the reading range. (See "Adjustments".)



ADJUSTMENTS

FIG. 11

(b) The lucite light conducting rod may now be slipped over the lamp on one end and locked into position by the screw on the other end.

7. MARKING PENCIL

To replace the marking pencil, merely insert it and push into place until the pin on the trigger falls into its notch (Figure 9). Put in new marking lead.

8. BRAKE

(a) If the drum brake has been removed and is replaced, its final position is determined by screw "U" (Figure 11). Tightening the screw decreases the brake action; backing off the screw increases it. There should be sufficient brake action so that the drum will not accidentally be rotated by ordinary handling of the Sextant, but the tension should not be such as to interfere with easy turning of the drum by hand. Replace cover, making sure that the edges fit securely all around. Replace drum.

(b) When the drum is replaced, the positioning pin "V" (Figure 11) must line up with the large pin "W". If the two pins do not line up, merely raise the drum flange "L" and rotate it as necessary.

9. FILLING BUBBLE CELL

A special Bristo set screw will be observed on the recessed (small) end of the bubble housing. This screw must be removed with a standard Bristo wrench. Fill a hypodermic needle in Xylene CP. (Chemically pure xylene is specified since commercial or purified grades are not sufficiently pure for use in the bubble chamber.) Turn the bubble housing so that the inlet is at the top, and insert the needle into the opening where the set screw has been removed. Add small quantities of xylene until the desired size bubble is obtained. If too much fluid is injected, the hypodermic needle should be emptied, the assembly turned with the inlet to the bottom, and the chamber partially emptied by forcing in air with the needle. Repeat the procedure for filling.

Note that the bubble is formed by filling the chamber with fluid and not by withdrawing fluid or by injecting air into the chamber.

When the proper size bubble has been obtained, the set screw should be replaced and snugged into place. Since the special pointed screw seats on a relatively sharp edge, it is not necessary to apply excessive pressure in replacing this screw.

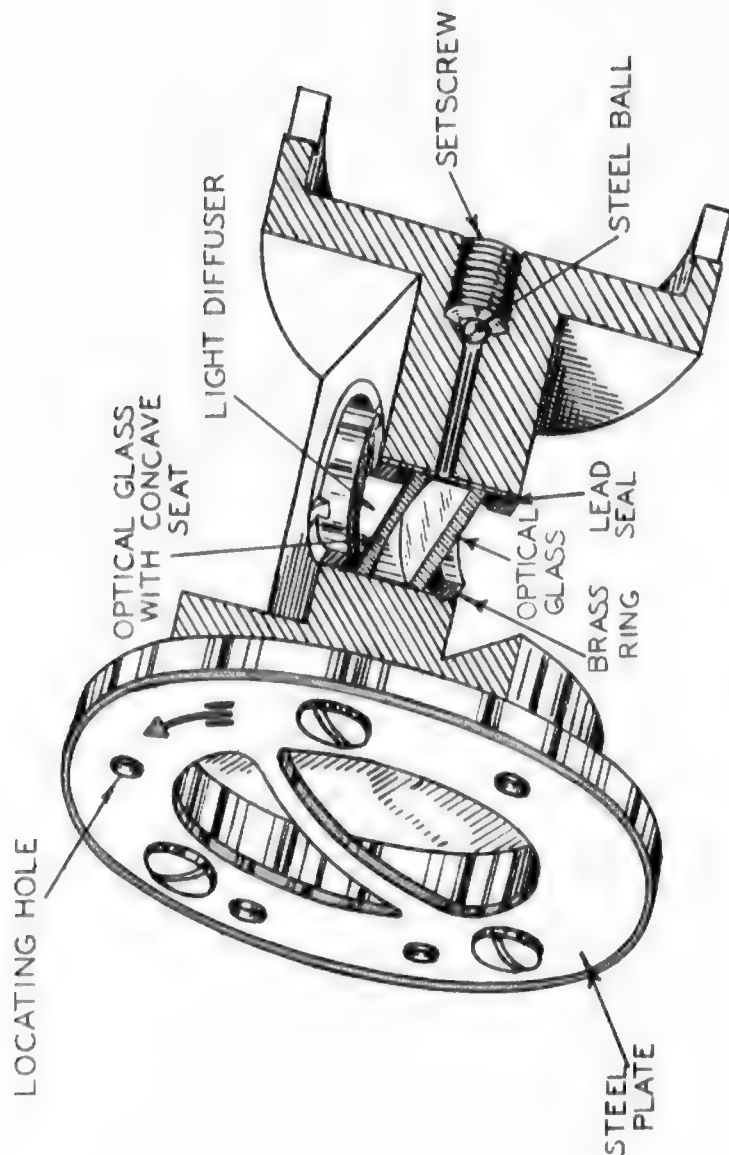
All bubble assemblies, beginning with bubble assembly serial number 1,000, are provided with a small steel ball underneath the Bristo set screw in the tapped hole through which the bubble cell is filled. Caution must be exercised when removing the set screw to prevent the ball from dropping out and becoming lost. The ball should be removed when refilling the chamber and must be replaced before tightening the set screw to prevent the cell from leaking. (See Figure 12.)

Occasionally, even when great care is exercised in filling a bubble cell, small bits of dirt or other foreign matter get into the chamber. Also, due to a variety of reasons, a bubble may be somewhat sluggish. In any of these cases, the foregoing procedure is executed, but the method of emptying the chamber is that of forcing in air and refilling several times with clean fluid to remove any impurities.

Do not attempt to clean a bubble chamber by injecting fluid and then withdrawing it with a hypodermic needle. It must be forced out with air, since by withdrawing the fluid with a needle, the dirt is simply lodged in the hypodermic cell or the needle itself, and will generally find its way back when the bubble is refilled.

10. CAUTION:

WHEN THE INSTRUMENT IS COMPLETE, THERE MUST BE NO BIND ANYWHERE IN THE MECHANISM AND THERE MUST BE NO PLAY OR LOST MOTION BETWEEN THE INDEX MIRROR SHAFT AND THE HOUSING. ACCURACY CANNOT BE OBTAINED OTHERWISE.



BUBBLE ASSEMBLY

FIG. 12

SECTION VII

ADJUSTMENT

1. General
2. Objective Lens
3. Index Mirror and Vernier Plate
4. Bubble Housing
5. Index Error
6. Marking Pencil

1. GENERAL

Adjustment of the Sextant requires that an object of known altitude be used. By sighting upon this object, the Sextant is properly adjusted to give the same reading as the known altitude. One method of doing this is by making use of a celestial body at a pre-computed altitude and time, and then checking that the indicated altitude, suitably corrected for refraction, etc., agrees with the computed altitude.

A much more convenient and in general more accurate method of checking error is by use of a collimator such as the Link Test Collimator, which may be set to any desired altitude. For example: let it be supposed that the Sextant is to be checked for index (scale) error. Simply set the collimator to any altitude (say 30 degrees even), center the collimator "star" in the center of the bubble, and adjust the vernier scale of the index to indicate exactly 30°.

If the Sextant is once adjusted with a certain bubble chamber in place and another bubble assembly is to be inserted, it is quite probable that the readings with the second assembly will be in error. This is due to the fact that in the process of manufacture, bubble assemblies will vary slightly; consequently each bubble assembly must be adjusted to the Sextant with which it is to be used. After several assemblies are once adjusted to a particular Sextant, they may be interchanged at will. The method of adjustment is described in the following paragraphs.

2. OBJECTIVE LENS

(a) With the Sextant completely assembled and all parts working properly, the first step is to focus or collimate the bubble objective lens. This focusing is accomplished by means of the threaded adjustment which carries the lens. It will be observed that the threaded member in which the lens is contained is notched

so as to facilitate the adjustment. It is advisable to use a tool that will properly fit these notches. This adjustment should be screwed in or out, as necessary, until a clear image of the bubble is obtained.

(b) Next, remove the eye piece bracket from the Sextant and mount the Sextant on a tripod. Adjust the Sextant altitude so that a star (actual or collimated) is in the top edge of the black rim of the bubble. Move the head and eye up and down as far as possible without losing sight of a clear image of the bubble. When the objective lens is properly focused, the star will retain its position on the rim of the bubble throughout the above movement. If the lens is not properly focused, the star will appear to move away from the bubble rim as the head and eye is moved up and down. To correct this, make slight adjustments to the lens as outlined above. When the star remains fixed relative to the bubble, regardless of movement of the eye across or over the entire field of vision, the collimation or focusing is correct.

3. INDEX MIRROR AND VERNIER PLATE

See that the vernier plate on the Sextant arm is approximately midway between the extremes of its adjustment range, then by means of the drum, crank the arm to forty-five degrees altitude (this being a convenient adjustment angle). Using a collimator set at forty-five degrees, adjust the index mirror until the reflected image coincides with the center of the bubble. Clamp the index mirror to its shaft and check the arm again to see that it is still at forty-five degrees (it may have shifted while the clamp was being tightened). If the star is off center more than an amount equal to one-half the width of the bubble rim, (not the width of the whole bubble), the index mirror should be readjusted to get as near to the center as possible. Any remaining small adjustment should then be made on the vernier plate. During this final adjustment, the clearance between the vernier plate and the altitude scale should be established between two and four thousandths of an inch. Replace the eye piece bracket, and the Sextant is ready for use. The Sextant is now adjusted for the particular bubble assembly which is in place; any further adjustments for other bubble assemblies are made with the assemblies themselves and not with the index mirror. (See Paragraph 4, "Bubble Housing".)

4. BUBBLE HOUSING

The spare bubble housing assembly for any given instrument should be carried in the case with that particular instrument. Before this bubble assembly is added to the case, however, it should be adjusted to that particular Sextant. In making this adjustment to a second bubble assembly, all of the adjustment must be done in

the bubble assembly itself so as not to disturb Sextant adjustments which fit the original bubble assembly.

It will be noted that the handle by which the bubble housing is removed from the Sextant is part of the positioning plate disc which contains five screws and two dowel pin holes, the purpose of which have already been mentioned in an earlier section. The back end of the bubble housing assembly is notched by means of which the housing assembly may be rotated.

To adjust spare bubble assemblies to agree with a Sextant which is already in proper adjustment, proceed as follows: With the Sextant mounted on a tripod and trained on a star or other object, as previously outlined, carefully adjust the Sextant so the object is exactly centered in the bubble. Note the Sextant reading. Remove the original bubble assembly and replace it with the one that is to be adjusted. Then note the position of the bubble relative to the object. If the object is not exactly centered in the bubble, loosen the three small screws after slightly backing off the two knurled screws. By means of the notches on the back of the bubble housing, rotate the housing as necessary to exactly center the bubble over the object, simultaneously checking that the dowel hole (with the arrow) is against the pin. With the bubble properly centered, tighten the three small screws and recheck the bubble position.

When this adjustment is carefully completed, the bubble assembly is ready for use in the Sextant. Again it is emphasized; once the bubble chamber has been adjusted to the Sextant, the three small screws must not be disturbed at any time.

5. INDEX ERROR

Once the above settings have been accomplished, there should be no error in the instrument excepting for scale error and errors set in by means of mishandling. These errors may be found by setting a collimator up at various altitudes and checking to see if the Sextant agrees with these readings. If there is a difference, and usually it is less than plus or minus two minutes, this difference is called the index error or instrument correction. Errors greater than plus or minus two minutes should be eliminated as described under Section VII, paragraph 3 - "Index Mirror and Vernier Plate".

The index correction is plus when the Sextant reads less than the collimator setting and the correction is minus when the Sextant reading is greater than the collimator setting.

Example: Set the collimator to 30 degrees and adjust the Sextant to center the star in the center of the bubble in center of the field. The Sextant scale reads 29 degrees 58 minutes instead of 30 degrees.

Therefore, the index correction is plus 2. The index correction would have been minus 2 if the Sextant had read 30 degrees 2 minutes.

6. MARKING PENCIL

The only adjustment required is that of the marking lead itself. This lead should be sharpened to a point and positioned such that when the trigger is pressed, a definite line will be traced on the recorder drum. Care must be taken that the lead will not press hard enough to cause it to break. The position of the lead is locked in place by a set screw.

SECTION VIII

MAINTENANCE

1. Batteries
2. Sun Shades
3. Index Mirror
4. Temperature Effect
5. Lubrication

1. BATTERIES

Always remove the batteries from the battery cases. This is necessary to prevent old (dead) batteries from expanding and corroding. When a battery expands it "freezes" the case to the Sextant housing necessitating cutting the battery case and reaming out the corroded parts. Replace batteries as soon as they become noticeably weak. See that there are four fresh batteries in the case at all times.

2. SUN SHADES

Make sure the shade glasses are closed or in the clamped position before placing the Sextant in the box in order to avoid breakage.

3. INDEX MIRROR

Keep fingers off the index mirror. The oil from the fingers, if left on the index mirror for a short time, will etch the glass causing distortion of the observed body. This leads to errors in altitude shots. This applies also to the shade glasses since they too will be etched by the oil from the fingers.

It is also very important not to rub the index mirror with anything but soft cleansing paper such as lens paper, etc. This, too, applies to the filters. When adjusting the filters touch only the edges of the glass, but not the flat areas.

4. TEMPERATURE EFFECT

Except for change in the size of the bubble, extreme temperatures do not affect the operation of the Link Sextant.

In cold temperatures the bubble will increase in size. It has been found in practice that the bubble may be warmed sufficiently for a series of sights by holding it in the hand or pocket just prior to taking the sights.

In warm temperatures the bubble will decrease in size. Decrease in size may be noticeable when the Sextant is used on the ground

during hot weather. However, in flight, temperatures are usually sufficiently low so that the bubble size is approximately normal.

5. LUBRICATION

When repairing the Sextant use a light lubricant such as vaseline on the gears and shafts. If it is known that cold operating conditions are to be encountered for a period of time it is best to lubricate with a light gun oil.

SECTION IX

PARTS LIST

1. Numerical Parts List

2. Assembly Parts List

1. NUMERICAL PARTS LIST

<u>PART NO.</u>	<u>NOMENCLATURE</u>	<u>TOTAL QTY. PER ARTICLE</u>
6407	Case - Marking Lead	1
6841*	Screw-Drive Parker Kalon Type "C" #2 x 1/8	2
7096	Screw - Fill. HIM #5-40 x 5/16 White Nickel	4
7107	Eyelet - .085 Dia. x 1/8 Brass	1
7198	Clip - Spring .094 x .020	1
7630	Plate- Sextant Patent	1
7654	Plunger - Pencil Pressure (See 11653 for old Order No.)	1
7655	Screw - Set Bristo Hdless 1 Cup Point #6-32 x 1/9 (See 11316 for Old Order No.)	1
7819**	Screw-Drive Parker Kalon Type "U" #00 x 1/8	4
9296	Plate - Sextant Name (Commercial)	1
9344	Screw - RHEM #2-56 x 3/16 Painted	8
9419	Diffuser - Bubble	1
10260	Wire - #20-Stranded Tinned Copper White - Blue Tracer	10"
10606	Screw - O. H. Fill. I.M. #5-40 x 1/4	1
10984	Cement - G. E. Glyptal	1
11316	Screw - Set Bristo Hdless 1 Cup Point #6-32 x 1/9 (See 7655 for New Order No.)	1
11500	Drum-Median	1
11501	Knob-Rheostat	1
11507	Lens - Sextant	1
11510	Rheostat - 30 OHM	1
11529	Shaft-Vernier Arm (Median Type)	1
11533	Clip - Sun Shade	1
11535	Ring - Bubble Window Locking	1
11537	Strap - Housing	1
11538	Window - Bubble	1
11539	Piece - Eye	1
11546	Ring - Lens Locking	1
11561	Shaft - Sun Shade Bearing	1
11564	Arm - Sun Shade Frame (Oxidized)	1
11566	Washer Brass - .192 - .188 x 5/16 x .053 - .049	1
11567	Shim-Vernier (.002)	1

* AN535-2-2

** AN535-002

<u>PART NO.</u>	<u>NOMENCLATURE</u>	<u>TOTAL QTY. PER ARTICLE</u>
11572	Lamp - 2 Volts - .06 Amps	1
11573	Battery-Size "C"	2
11574	Bearing-Flanged Oilite (F-336)	1
11577	Bracket Assembly - Eye Piece Holder	1
11578	Dowel - Bubble Chamber	1
11582	Gear - Countershaft	2
11589	Bearing-Flanged Oilite (F337)	1
11600	Tube-Vernier Illuminating	1
11605	Trigger - Pencil	1
11608	Cap - Battery Housing	1
11609	Arm - Pencil	1
11610	Bracket - Countershaft Bearing	1
11611	Bead - Forehead	2
11613	Lamp - 1.1 Volts - .22 Amps	1
11618	Support - Auxiliary Battery Switch Contact	1
11619	Button - Aux. Battery Switch	1
11620	Contact - Auxiliary Battery Switch	1
11622	Screw - Fill. HBM #2-56 x 1/4 (Black Oxidized)	3
11624	Spring - Auxiliary Battery Switch	1
11627	Plate - Forehead Rest	2
11628	Screw-Cap Bristo Socket Hd #5-40 x 3/8	1
11631	Spring - Gear Take up	2
11637	Housing - Bubble Lamp	1
11651	Screw - Pencil Clamping	1
11653	Plunger - Pencil Pressure (See 7654 for new Order No.)	1
11657	Shaft - Trigger	1
11658	Pin - Trigger	1
11662	Pad - Brake	1
11665	Screw - Lens Tube Locking	1
11667	Screw - Cover	1
11668	Spring - Pencil Plunger	1
11672	Sleeve - Lens Adjusting	1
11674	Scale - Vernier (Black)	1
11675	Scale - Altitude (Black)	1
11676	Screw-Fill. HBM #5-40 x 3/4 Black Oxidized	3
11680	Stud - Aux. Battery Terminal	1
11681	Insulator - Aux. Battery Term. (Long)	1
11682	Insulator - Aux. Battery Term. (Short)	1
11685	Screw - FHEM #6-32 x 3/8 Black Oxidized	1
11691	Screw RHEM #5-40 x 5-16 Black Oxidized	3
11698	Screw - Vernier Scale	2
11699	Screw-FHEM #2-56 x 1/8 Black Oxidized	1
11701	Cover - Median Type Housing	1
11703	Screw-RHEM #6-32 x 3/16 Black Oxidized	1
11709	Clamp - Wire	2

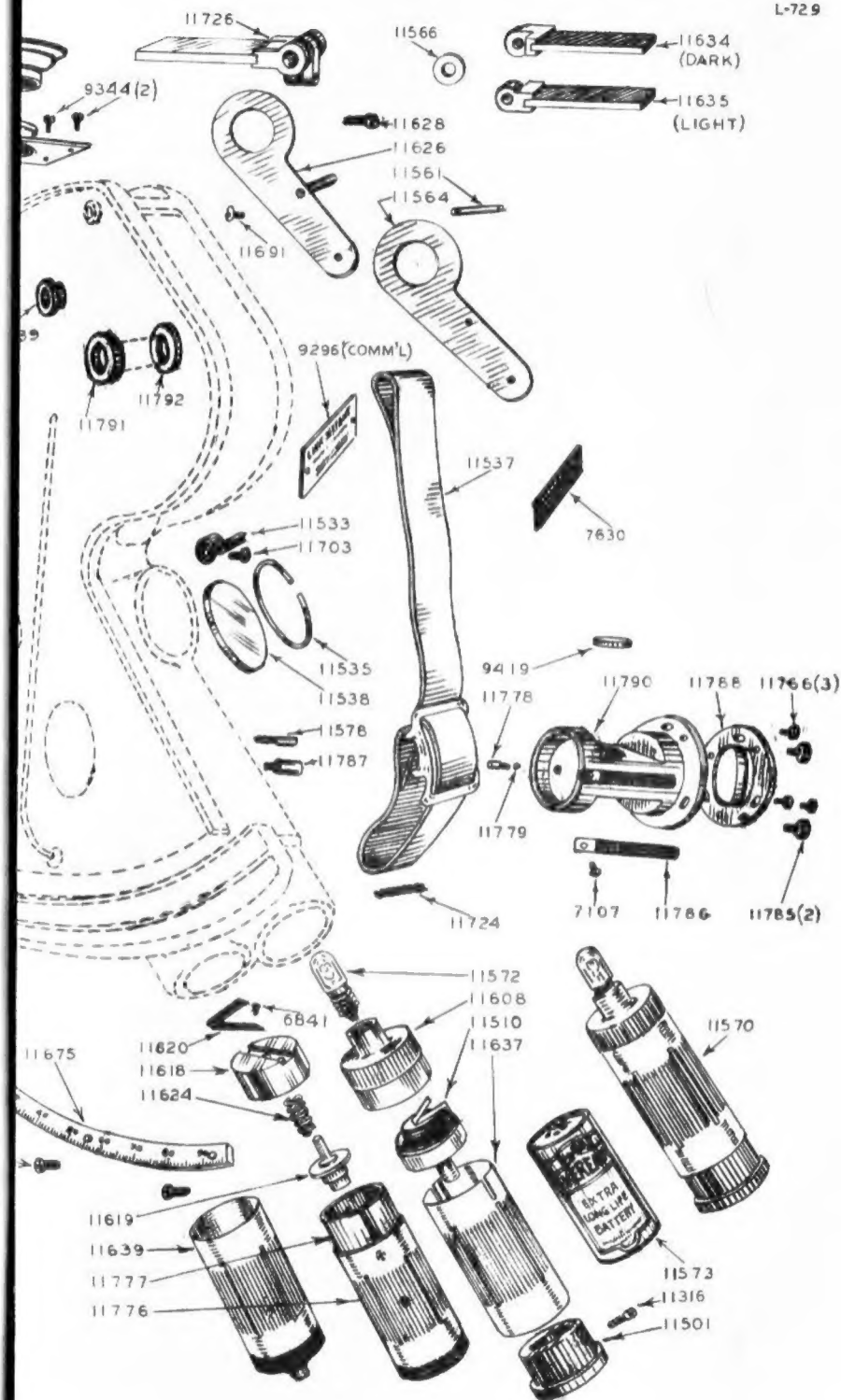
<u>PART NO.</u>	<u>NOMENCLATURE</u>	<u>TOTAL QTY. PER ARTICLE</u>
11710	Bushing- Aux. Battery Terminal	1
11721	Plate - Sextant Name (Army)	2
11723	Shim - Vernier (.005)	1
11724	Spring - Strap Hanger	1
11756	Lead - Marking	1
11766	Screw - BHIM #5-40 x 3/16 Chrome Plated	3
11769	Spring - Countershaft Gear Take Up	2
11770	Clip - Spring (Oxidize & Lacquer)	2
11776	Housing - Battery	1
11777	Bushing - Battery	1
11778	Screw-Set Bristo Full Doz Pt. #5-40 x 3/16	1
11779	Ball - 1/16 Hardened and Polished Steel Ball Bearing (See 11794 for new Order No.)	1
11785	Screw-Bubble Clamp	2
11786	Spring - Bubble Housing	1
11787	Stud - Bubble Stop	1
11788	Plate - Spherical Bubble	1
11791	Bearing - Oilite .374 x .475 x .350	1
11792	Bearing - Oilite .374 x .475 x .250	1
11794	Ball - 1/16 Hardened and Polished Steel Ball Bearing (See 11779 for old Order No.)	1

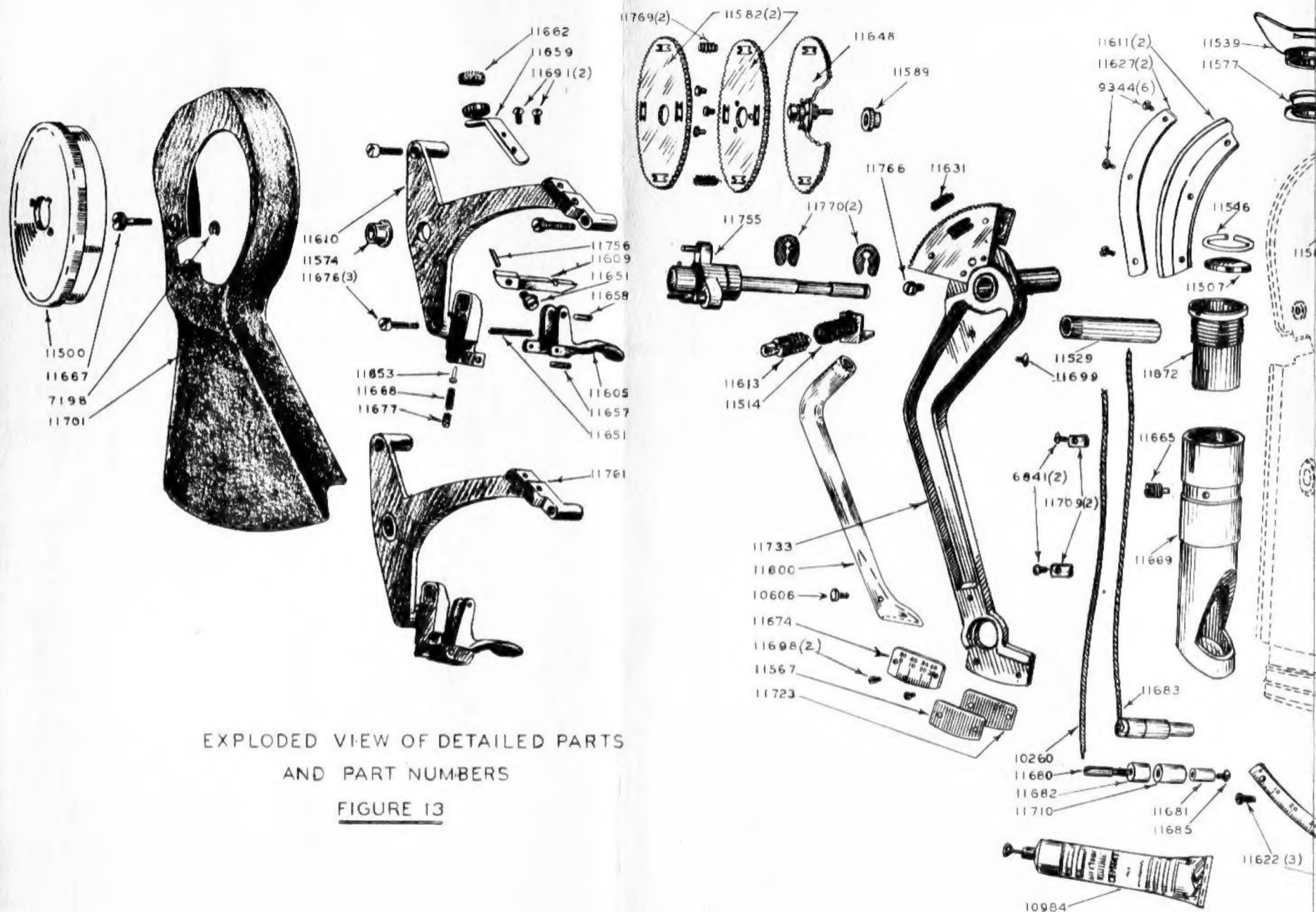
2. ASSEMBLY PARTS LIST

<u>PART NO.</u>	<u>NOMENCLATURE</u>
11570	Bubble Lamp Assembly
11626	Arm Assembly-Sun Shade Frame
11634	Shade Assembly-Sun (Dark)
11635	Shade Assembly-Sun (Light)
11639	Vernier Lamp Assembly
11648	Counter Shaft and Gear Assembly
11659	Brake Assembly - Drum
11683	Terminal Assembly - Vernier Lamp
11688	Sleeve Assembly - Lens Adjusting
11726	Minor Assembly - Index
11733	Arm Assembly - Median Type Vernier
11755	Shaft Assembly - Drum
11760	Trigger Assembly - Median Sextant
11761	Bracket Assembly - Trigger and Counter Shaft Bearing
11790	Bubble Assembly - Spherical
11514	Socket - Miniature Screw Base

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EXPLODED VIEW OF DETAILED PARTS
AND PART NUMBERS
FIGURE 13

